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erally available production is limited.

If wood may rightly be called the principal article for export in Austria, one must not forget that continuation of this export has been possible only on account of the large stock which had accumulated thanks to the conservative forestry system of pre-war times. Owing to this large reserve stock Austria is still able to export wood despite its being used as fuel to a much greater extent than before. It will soon follow, as a matter of course, that highly valuable timber will have to be used as fuel and great damage will ensue to the economics of the Republic.

The efforts of the Austrian Government have been so far successful in bringing about an improvement of the coal supply of the country. There is reason to hope, therefore, that the prophesied economic harm may not result but that, on the contrary, Austria's natural riches in wood may in the future suffice to meet the demands both foreign and domestic.

The problem of recolonization has developed as a consequence of the injurious effects of the repeated selling out of small farms, which had fallen into trouble, by the great landed proprietors. The dimensions to which this so-called *Bauernlegung*, selling out of peasant farms, has grown, may be gathered from the fact that within the last fourteen years over 12,000

smaller farms have been assimilated by the great landed estates. The colonization law (*Wiederbesiedlungsgesetz*) of the year 1919 slipped a bolt, here, by decreeing that under certain conditions all such farms or cottages as could be worked individually and had been independent since 1870, should be returned to the farmers who had formerly been on them. Naturally the preparatory work took some time, so that the lists of the farms fit for colonization were finished only in June, 1921. An idea of the number of farms concerned may be gathered from the fact that in 240 communities of Lower Austria, alone, 1,100 farms have been entered in the registers. The opposition of the great landed proprietors has been so far vanquished by the pressure brought to bear on it by the peasants that in many cases they were ready to enter into negotiations with the peasantry. This peaceful adjustment serves to accelerate the enforcement of the colonization law, since the long investigation of the colonization commissions and the delays caused by remonstrances, which might be raised in the course of the legal procedure, may be thus avoided.

By such measures Austrian agriculture may soon be intensified, a development which, in the light of the preceding statements, is a consummation to be sincerely wished by every Austrian.

CHAPTER III

The Water Power Question in Austria

By DR. FRIEDRICH HERTZ

Vienna

AUSTRIA'S poverty in coal is partly compensated by the abundance of her water power; nor is the statement correct, though so often repeated, that

Austria has as yet made no real use of this natural resource. There are now in existence innumerable old power stations beside many modern installa-

tions. Nevertheless, Austria certainly does appear behindhand compared with the progress made in hydro-electricity by Scandinavia, Switzerland, Italy and France. The reason for this is that in the old days coal could be obtained to such advantage from Ostrau and Upper Silesia that many factory owners shied at the considerable outlay of capital involved in the installation of water power. The utilization of water power is in itself a lengthy and costly process, and the lack of capital in a war-worn country is a great obstacle in the way of the realization of extensive schemes.

ESTIMATES OF WATER POWER PROSPECTS

The various estimates of the power available differ considerably according to the extent of the power included. As a rule, the estimates include only the larger sources of water power; some are based on low water, others, on a medium water, etc. The water power prospects of the Austrian Alps have been thoroughly investigated by many experts, official and otherwise, and extremely valuable and practical information is at the disposal of anyone interested. The State Hydrographical Central Bureau has prepared a schedule of most of the water courses, giving statistics and diagrams of all hydrological and other data appropriate for the development of water power. The various sheets of this schedule may be bought singly. Moreover, the management of the State Railways has for years been studying the utilization of water power and the adaptation of the railways to electricity, and its investigations have likewise yielded an almost complete description of the chief sources of water power. The principal results are contained in the report, "Mitteilungen über die Studien zur Ausnützung der Wasserkräfte"

(Government Printing Office, 1917). The Appendix to this valuable work contains a list of 433 important sources of water power in the Alps, indicating their respective HP capacity.

The result of these investigations on the part of the State Railways Administration was the conclusion that in the Alpine regions then belonging to Austria, about 3 million HP of water power were available which could be usefully employed under the economic conditions then prevailing; of these only 250,000 HP (*i.e.* only 8 per cent) were at that time already in use. It must further be remembered that the enormous increase in the price of coal which exceeds the increase in the cost of building, has enlarged the possibilities of profitably installing hydraulic power. Under existing conditions, water power may be used with advantage which would not previously have paid, and the financial possibilities have altogether increased. The reason for these altered conditions is that about half the cost of installing hydraulic power consists of wages, which have not increased to the same extent as the price of coal, which has to be paid for in foreign currency.

On the other hand, the figure of 3 million HP has been reduced, as important sources of water power are situated in the territories ceded under the Peace Treaty. In particular, the German part of the Southern Tyrol, which has fallen to Italy's share, is a district very rich in water power; also, the German districts of Marburg, which fell to the share of Jugo-Slavia, and of Südmähren, which went to the Czechs, possess valuable water power. If we reckon up the sources of Alpine water power examined by the Administration of State Railways that now remain within the restricted frontiers of Austria, the result is a mean yield of about 1.4 millions a year. How-

ever, as the estimate does not include many smaller sources of power, and as the district to the north of the Danube also contains considerable water power, *the total available water power of German Austria worth using would give a mean annual yield of about 2.5 millions.*¹

WATER POWER FOR COAL REPLACEMENT

If we accept the figure, customary in industry, of 3,000 hours' use, we arrive at the conclusion that, theoretically, *all the water power of Austria, fully utilized, would provide a substitute for 7.5 million tons of black coal, or about 11.25 million tons of lignite, i.e., considerably the greater part of the quantity of coal which Austria is now obliged to import.* This calculation does not regard the fact that many water powers can be used twenty-four hours a day which, of course, increases still further the quantity of coal replaceable.

According to official estimates, about 7 million tons of coal, at present used to provide power and light for railways and industries, could at once be replaced by means of water power; whereas, the coal required for heat for industrial purposes (1.5 million tons) and for household use (4.2 million tons) could be replaced by electricity only if the price of coal were extremely high, and even then could be only partially replaced.² For the present, it is prob-

able that gas will be used mostly for cooking, as this is the best way of making complete use of coal, whereas gas lighting will gradually give way to electric lighting.

Unfortunately, however, the practical realization of this object cannot be expected in the immediate future. Even before the war, when Austria was comparatively rich in capital, it seemed impossible to raise funds for carrying out an extensive program for the development of water power.

The steep descent of the Alpine streams makes high pressure installations possible, and these are for the most part cheaper and quicker of installation than the low pressure installations on streams and rivers of the plains. However, even the best high pressure stations of our Alps produce their energy at greater cost than the large stations on the seacoast of Norway and Dalmatia, which must therefore be regarded as important competitors on the world market in electro-chemical products which necessitate large quantities of the cheapest current.

Under existing conditions matters have taken a turn in favor of Austria. For many years now, a few large electro-chemical undertakings, aluminum, calcium carbide, iron products, nitric acid, calcium nitrate, etc., have established themselves in the Austrian Alps and are working with good results. With the help of electro-chemistry, Austria would be able to replace

¹ Proof that the investigations of the Administration of State Railways have not exhausted all the water power resources is provided by the example of the Danube, which appears on the list with only three stages with a total yield of 242,000 HP. Even if only a small amount of water is withdrawn from the Austrian part of the Danube the power obtainable may be estimated as at least half a million HP; optimists have given even higher estimates.

² A thorough and practical study of the Swiss electrical works (c. f. *Elektrotechnische Zeitschrift* 1919, Vol. 40, 41) has led to the conclusion that 1 kilogram of good coal used in a reliable central heating installation equals 4 to 5 kilowatt

hours; used in a good separate stove, 1.8 to 2 kilowatt hours; in ordinary inferior separate stoves, 1 to 1.2 kilowatt hours. Further, experience has shown that cooking by electricity is not more costly than gas cooking, if one kilowatt hour for cooking purposes costs half to one-third of one cubic metre of gas. According to this, the use of water power for heating might be a sound economic proposition even in Vienna under present conditions. This is particularly applicable in cases where cheap night current is available and where the heat can be stored.

many raw materials from abroad, which the present rate of exchange has placed almost beyond her reach.

The water power available in the Alps is subject to considerable fluctuations according to the season, and it is difficult to balance these fluctuations. The construction of reservoirs for preserving the water against drought is for the most part impracticable in the Alps, which are limestone, because the geological formation of the substrata and of the sides of the valleys would make the construction of the walls of the reservoirs very difficult, and, further, because the large quantities of rubble carried along by the Alpine streams would fill up the tanks. In this respect, the districts to the north of the Danube, which are on primeval rock, are better, as they offer a solid foundation and smaller deposits of silt. But even in the Alps there are parts where lakes or other suitable spots can be used for storing water, and the Administration of State Railways is now studying the possibilities of utilizing several such suitable localities.

ELECTRIFICATION PROJECT OF THE STATE RAILWAYS ADMINISTRATION

The former administration of the Austrian State Railways had already secured twenty-four water power stations, with a mean annual yield of 125,000 HP, beside a number of options with a view to the electrification of the Alpine railway. Twenty of these power stations are within the territory of the Austrian Republic. The existing Austrian State Railways require electricity to the extent of about 116,000 HP mean annual yield.

The lengthy investigations of the Administration of State Railways have before the War often been deprecated as being an obstacle in the way of the utilization of water power. Since the electrification of the railways of-

ferred formerly no financial advantages in view of the prices then ruling for coal, and since, moreover, the Army Staff objected to it from the military point of view, the Administration of Railways was not in a position to proceed with the work, nor could it release the water power to private enterprise. Now these obstacles have ceased to exist and the Administration of State Railways has worked out an extensive program for the electrification of the Alpine railways,³ which is already being carried out.

The Railways Administration has demonstrated by figures that the execution of the scheme would introduce considerable economies in coal, engines and coal trucks, staff and time, thus making the whole traffic cheaper, more regular, quicker and capable of increased business; moreover travelling would become pleasanter. The idea is, in the first place, to electrify the Western State Railways, traffic on which is most important, and which represent 40 per cent of the mileage and 50 per cent of the coal consumption of the State Railways. It would take from twelve to thirteen years to complete the adaptation. Five of these lines would be worked upon first, representing 14.6 per cent of the State Railway system. This would mean an annual saving of 400,000 tons of coal (at 4,500 calories) *i.e.*, about 12 per cent of the total requirement of the State Railways and 5 per cent of the total requirement of Austria. Given favorable conditions, the electrification of these five lines might be completed in about five or six years. The cost for these lines is calculated at 5.1 million kronen, and the annual saving of coal at 327 to 424 million kronen. Of course all these cal-

³ C. f. the very valuable statements affixed to the draft of a law concerning the introduction of electricity and motive power for railways, etc. 1920, which gives a full survey of the matter.

culations are very uncertain, as future price developments cannot be foreseen. The requirement of power will be covered by the development of certain works in Vorarlberg, Tyrol and Salzburg.

WATER-COAL SUBSTITUTION SCHEMES IN VIENNA

The most urgent question, however, is to substitute coal in Vienna and the surrounding industrial area of Lower Austria. More than half the population is contained in Lower Austria, besides two-thirds of the heating surface of all the boilers of the country. Of the rest of the population and of the boilers, about half is contained in Styria. But whereas Styria is rich in coal and water power, and whereas the remaining provinces can easily be connected with certain power stations, Vienna presents a more difficult problem. The energy generated in the Alps can be transmitted to Vienna only at great expense and with great loss of current. The most suitable plan would be to use the water power of the upper Enns (about 79,000 HP mean yield); its energy could be transmitted to Vienna by means of a 170 kilometer transmission line. Up to the present, however, the province of Styria, in whose territory this installation would come, has opposed this course in order to reserve the power for Styrian industry. This attitude is a sign of regrettable local interests, for Styria can cover her requirement from plenty of other streams, whereas Vienna has no such choice. Quite recently, however, Styria seems to have modified her attitude.

The city of Vienna has in consequence of these difficulties decided, in the first place, to develop the water power of the upper Ybbs (13,000 HP mean yield), and to connect with this a smaller station, Kienberg-Gaming (about 5,300 HP). The 120 kilometer

transmission line of the Ybbs station (110,000 volt tension) is being adapted to yield 35,000 HP, and the situation of the locality makes it possible, if desired, later to connect with it part of the power of the Enns, should the present difficulties be overcome. The time it will take to get the Ybbs Station in working order is calculated at three to four years, and for the Enns Station, five to six years; an advantage of the combination of both works is that their respective low water periods set in at different times of year. It is further designed to bring the above mentioned transmission in connection with the project of Persenbeug (a loop of the Danube with a mean yield of 7,200 HP) and with the Lunz coal mines at present about to be opened by the city of Vienna. The scheme, therefore, promises to make use of a quite substantial amount of power within a comparatively short time. Further it should be remembered that the power of the Ybbs can be accumulated by means of the Lunz Lake and by blocking the valley, to compensate for the variations in the flow of the water and achieve a regular supply of current. In any case, this scheme seems to hold much more promise than, for instance, the daring project of the Krems-Kamp Works (continuous annual yield of 27,000 HP), which would involve unduly great technical difficulties, or the power stations of the Thaya and the Drau, which it was formerly thought might be used for supplying Vienna, but which are now in Czech or Jugo-Slav territory.

Nevertheless, there are various objections to the development of the water power of the Ybbs, these objections being raised by the adherents of the Danube scheme, who are afraid that the execution of the less ambitious project would indefinitely postpone installation of the much larger Danube

works. They state that, if the standing annual requirement of Vienna were covered by these smaller works, there would be no prospect of developing the important water power of the Danube for the remaining irregular requirements, which vary considerably, since this would not be a financially paying proposition.

THE DANUBE AND OTHER PROJECTS

The Danube, it is true, would be capable of supplying an enormous quantity of power, and there are in existence a large number of schemes, in a state more or less developed. The Wallsee scheme, in Upper Austria, is the only one which is ripe for execution. Its mean yield would be 140,000 HP at a rate of 1,350 cubic metres per second; the energy could be transmitted to Vienna by means of a conduction 130 kilometers in length. This scheme entails the building of a dam on the Danube and has given rise to many objections on account of the danger of floods and ice. The concession for the work has, however, been granted upon such conditions as would appear to avoid these dangers and the interests of shipping have also been fully protected in the concession.

All the other Danube projects have been designed without the necessity of a dam, *i.e.*, with free flow of the stream. This has the advantage of avoiding the construction of a dam, which would be a lengthy and costly process; but, on the other hand, the water works would be dependent upon the state of the stream, so that there would be greater fluctuations, and very long canals and expensive constructions for regulating the current would be necessary.

In the Lower Austrian district, between Krems and March alone (*i.e.*, a reach of 120 kilometers long from Vienna) a maximum yield of 160,000 HP, or an annual mean yield of 140,-

000 HP, could be obtained without any prejudice to shipping; and this is calculating drawing water from the Danube only at the rate of about 400 cubic metres per second. The Communal Building Office of Vienna estimates the cost of construction at 211 to 270 million gold kronen.

The advantage of most of the Danube works consists in the large quantities of power they can extract, of the fact that they do not necessitate long conductions (in the case of the Lower Austrian reaches of the river) and of the fact that the necessary canals can be quickly dug by mechanical means and by unskilled labor.

The disadvantages, on the other hand, are as follows: great fluctuations in the flow of the stream; the necessity of a very long time for construction; danger to shipping by reduction of the quantity of water in the river and the accumulation of gravel in consequence of decreased carrying power. The last disadvantage can certainly be obviated by regulation of the stream and by dredging, but this would increase the expense. Whether power from the Danube would be cheaper or more expensive than the Alpine high pressure works mentioned above is doubtful. The Vienna Communal Building Office assumes that Danube horse power would be somewhat more expensive than high pressure power. It is generally found that low pressure power is dearer because it requires a larger quantity of water, and therefore the canals, sluices, machines, etc., have to be constructed on a larger scale. On the other hand, the high pressure works under consideration have the disadvantage of necessitating very costly tunnelling and boring and very long transmissions. The time needed and the expenses entailed by the Danube works depend chiefly upon whether a sufficient number of dredg-

ers and enough other building apparatus, trucks, etc., are available.

TREATY OF ST. GERMAIN AND WATER POWER DEVELOPMENT

In this connection, we must refer to Article 298 of the Peace Treaty of St. Germain, which prescribes that the interests of water power development are actually to take precedence of the requirement of shipping, but only on condition that a full agreement has been reached by all the States through which the river runs and which are represented on the Danube Commission. It is now feared that there may be some among these States which have no interest in freeing Austria from its dependence upon foreign sources of coal supply. *It is of the greatest importance that this question should be cleared up as soon as possible.* The Peace Treaty further provides for a Court of Arbitration to be appointed by the League of Nations with authority to deal with questions of this kind.

Before the War, Austria had introduced a complete reform of water rights and of electricity laws, representing the most modern point of view. The War, however, and the internal political situation put a stop to this reform. The local interest of the various states forms a barrier to uniformity of laws; besides, various states wish to use the water power available as much as possible for local purposes. But we may hope that in the end purely economic and commercial considerations will win the day. The individual states simply do not command the money to execute elaborate schemes without the help of the federal exchequer and of the financial institutions of Vienna. In Switzerland, for instance, the rivalries between the different Cantons caused similar difficulties; but in the end they did not

put a stop to the development of water power.

It is of primary importance that the law governing sources of electrical energy shall at last be settled, as otherwise the construction of long-distance transmissions is exposed to local obstructions and petty hindrances. It must further be considered whether in order to save coal industrial undertakings should not be compelled by law to make use of the electric power to be generated.

The Finance Ministry is encouraging the development of water power by allowing substantial dispensation from taxation. Several bills have been passed to this effect. Foreign capital invested in such undertakings will be free of capital levy, and all capital so invested will receive great advantages as to amortization. In any case, an extensive scheme for the development of water power can rely on the Austrian Finance Ministry for full approval and support.

WATER POWER—A PROSPECT FOR FOREIGN CAPITAL

To summarize the preceding remarks, it may be said that all legal and technical facilities for the most extensive development of water power in Austria are provided, and, further, that *the financial prospects for foreign capital are particularly favorable.* The immense increase in the price of coal has turned the tables in favor of water power, and even such water power stations as would hardly have been able to compete with coal before the War are now in a much more favorable financial position than coal power stations. While the price of coal has increased 120 to 150 fold, the cost of construction has risen only about 100 fold. Before the War the construction of one HP cost from 600 to 1,000 kronen. Moreover the dollar rate of

exchange has risen so enormously *that at the present rate of exchange American capital could develop the water power of Austria at about one-half of the expense in dollars that such an undertaking would have entailed in pre-war days.*

Austrian water power, therefore, can offer much better inducements in the international market than has ever been the case before; further, it could undoubtedly be used for the develop-

ment of an important electro-chemical industry and other such products as would find a good market on account of the low price at which they could be exported, *so that the foreign capital invested in the development of Austrian water power would also earn interest in foreign currency.* Such investments would be of inestimable advantage to Austria's whole economic situation.

CHAPTER IV

The Coal Supply of Austria After the Revolution of 1918

By RUDOLF KLOSS, D.L.L.

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THE Revolution at the end of 1918 completely upset the coal supply of Austria. The most important coal districts of Austria, the brown coal district of Northwestern Bohemia, the gas, coal and coke district of Ostrau-Karwin, the district of Trifail, fell to the Succession States, which immediately imposed hard conditions on the export of coal.

In Upper Silesia, which supplied most of the coal needed in Austria, the output was reduced to but a small fraction of its normal extent and therefore only quantities quite inadequate to the demand could be spared for Austria. The supplies from the Ruhr-Saar valley on which the western provinces of Austria (the Alpine Montan-Gesellschaft in particular) depended for coke for their blast-furnaces, ceased entirely.

So Austria had to fall back on her own coal production which has at all times come short of the demand and suffered a further reduction through the Revolution. Her inland coal, being

brown coal, lignite, was of inferior quality. It was clear, then, that the coal supply of the new Republic had to undergo a process of reconstruction under greatly changed circumstances.

DISTURBANCE OF COAL IMPORT DUE TO POLITICAL CONDITIONS

The unfavorable situation of the coal problem was further aggravated by the political conditions at home and abroad. The dismemberment of the old Monarchy into the several National States dealt a heavy blow to the competence of the central authorities. This made itself specially felt with regard to the coal supply. Some of the provinces took the coal administration into their own hands. But the economic pressure of those days caused not only the provinces but also some of the town and district councils, workmen's and soldiers' councils, military bodies and subordinate railway authorities to proceed independently in the coal question; they laid embargoes on all coal they could get.